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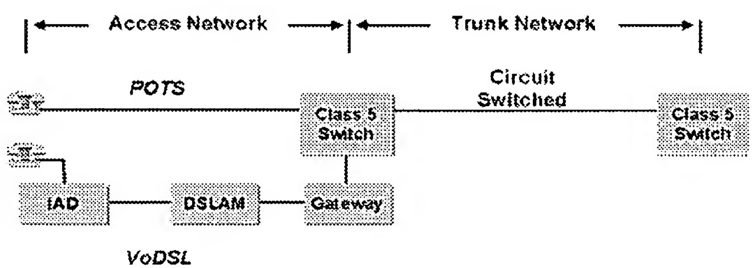
DSL FORUM

Voice-over–Digital Subscriber Line (VoDSL) Service—New Revenue from Existing Infrastructure

4. Broadband Loop Emulation Service (BLES) VoDSL

Two approaches are available to local-exchange carriers wishing to establish VoDSL service. One approach, broadband loop emulation service (BLES), extends Class-5 servicing office capabilities (custom calling and Centrex services, as well as trunking for customer premises equipment [CPE]), along with high-speed data services to customers over DSL (see *Figure 5*). Using the BLES approach, VoDSL vendors have designed equipment that interfaces with existing customer equipment, the DSL network, and the Class-5 switch (also called a local exchange in some countries).

Figure 5. BLES Architecture



Typically, a single piece of hardware is installed at the subscriber location and connected to the existing telephone system. This hardware is generally installed in the telephone wiring room of the building. Depending upon the vendor, the CPE and the DSL modem are separate pieces of equipment or can be integrated in a single unit. In most VoDSL implementations, the subscriber-side CPE is referred to as an integrated access device (IAD). Generally, the IAD provides an Ethernet or asynchronous transfer mode (ATM) port for data, and a number of voice ports for analog telephone lines, each representing a unique VoDSL circuit.

In the network, a voice or local-exchange gateway at the service provider's CO sends the VoDSL voice traffic to the existing Class-5 voice switch via a standard network interface such as GR–303 or TR–08 in the United States or V5.2 for countries that use European standards-based equipment. This approach is generally most cost-effective where the service provider already offers traditional voice services over an existing switching network and wishes to offer additional revenue-producing voice services over existing infrastructure.

The softswitch advantage

Softswitches and packet switching are transforming telecom network architectures. Steve Williams explains how calls between mobile subscribers in The Kingdom of Tonga are being controlled from Los Angeles

Telecommunications networks have already seen two technological revolutions. First, manual switchboard operators were replaced by automated switching control functions; secondly, analogue voice signals gave way to digital voice. Throughout these transformations, as the level of automation and the quality of the public switched telecommunications network (PSTN) improved by leaps and bounds, one crucial feature remained constant: the transmission of voice and the control of the path followed by voice remained located in a single physical entity - the telephone exchange in the case of the PSTN, and the mobile switching centre (MSC) in the cellular world.

The monolithic nature of the telephone exchange and the MSC leads to some interesting limitations. In particular, the hardware required is highly specialised, as it must combine the ability to switch telecommunications spans along with the provision of general processing capabilities for control functions. Both tasks can be highly demanding in resource terms. A call between two PSTN subscribers is not set up end-to-end, but piece-by-piece, much like a child joining the dots on a drawing. Each switch that the call traverses to reach its endpoint must treat the call as a new call. This means that if the path traverses five switching nodes, then it is treated as five independent calls within the PSTN network.

With the advent of packet switching, the PSTN is now on the verge of a third revolution. In a packet network, the transmitted signal, which could be voice, is broken up into small pieces called packets, which are numbered sequentially (so they can be put back together in order) and individually addressed, much as postcards in the mail. The packets are then posted onto a packet network, where the network itself uses the address to deliver the information to the ultimate destination, where all the packets are put back together in order.

Packet switching brings multiple benefits. In a packet network, a call is always treated as a single call, requiring far fewer resources than the equivalent PSTN call. Also, as the name implies, switching is now an inherent feature of the network, eliminating the need for dedicated intermediate switching functions. As a result, the functions that control the media path, for example setting up and tearing down calls, are now distinct and separate from the media path itself. This last feature means that is becomes eminently reasonable to physically separate the network operator and the network, so that, for example, a media-path controller in Los Angeles can control a direct voice path between two subscribers in The Kingdom of Tonga, in the south-west Pacific Ocean, without any intermediate switching resources or back hauling the call to the control point in Los Angeles.

Because the media-path controllers of packet networks do not need to incorporate specialised switching hardware, they can be implemented in software alone. Their apt name, 'softswitches', reflects this hardware independence. Softswitches require only a general-purpose processor and packet network connectivity, and, consequently, can take advantage of the latest off-the-shelf processors, making them many times cheaper and orders of magnitude more powerful than legacy telephone exchanges and MSC equipment (most of which were developed some 25 years ago).

Mobile telephony comes to Tonga

The attractions of packet switching and softswitch technology are clearly illustrated by Globecomm's approach to the provision of mobile voice, data and multimedia services for the Tonga Islands. The island location, plus Globecomm's extensive satellite network, provided a clear-cut pointer to the use of a satellite transmission network, but other technology choices were not so obvious.

Globecomm wanted to find the most innovative, flexible and cost effective solution. A traditional circuit-switched network solution was considered, but discounted due to technical and economic factors. The traditional approach would have required the implementation of two

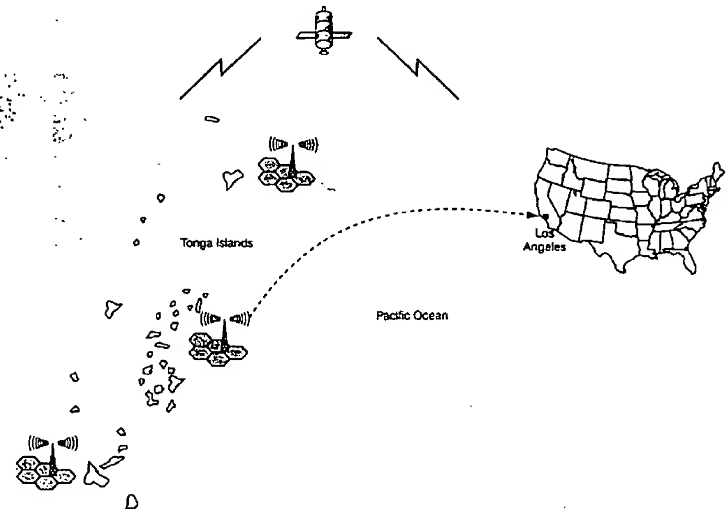
separate networks: a packet network for data and multimedia services, and a circuit-switched network for voice services.

The proposed network needed to cover three islands. Each had a local PSTN, and interoperability between this existing network and the new wireless network would clearly be essential. Using a traditional wireless infrastructure, two solutions were possible. First, implement a complete, independent, mobile switching system on each of the islands, including separate MSCs. Secondly, implement a single MSC (located on one of the islands or at Globecomm's Los Angeles headquarters) to control the base stations on each of the islands.

The first solution was discounted outright on the grounds of [illegible] costs; the second had been used in other network deployments, but incurs high operating costs. The base station equipment is not capable of switching calls, requiring all calls to be back hauled to the MSC for processing. This means that every local call, whether from a landline or from a mobile telephone, which originates from any island not housing the MSC, needs to be transported over satellite to the MSC, where it is switched and routed back to the originating island to complete the call. Such a local call results in two long distance links over satellite - an expensive operating proposition.

Having discounted the possibility of using a traditional circuit-switched solution, Globecomm chose to implement a next-generation, packet-based network architecture, using a wireless softswitch from Telos Technology. The use of a single packet network for voice, data and multimedia services brought significant savings in infrastructure and operational support costs. The wireless softswitch was deployed in Los Angeles, where it remotely controlled the base stations and PSTN gateways on each of the islands. Only control messages, using very little bandwidth, are required between the base stations, the gateways, and the wireless softswitch in Los Angeles. All local voice traffic is routed locally, eliminating costly back hauls. Los Angeles is also used as the connection point for international calls to and from the islands (Fig. 1).

The Telos solution has valuable benefits, over and above the achievement of substantial savings in equipment and satellite transmission resources. For example, the compression methods for voice traffic over satellite are implemented entirely in software in the media gateways, so that as new wireless or voice over IP compression algorithms are required, these can be realised solely with a software upgrade, i.e., new hardware is not needed. In addition, all network maintenance and support is performed



1 Softswitch technology has enabled Globecomm to implement a cellular network on the Tonga Islands, using a single softswitch located in Los Angeles and low-bandwidth control messages between Tonga and the softswitch. A more traditional approach, with an MSC located in Los Angeles, would have necessitated routing every call to the MSC for switching, imposing high bandwidth demands on the two-way satellite link

at one central location, Los Angeles. Globecomm is not required to employ and train local service personnel in the Tonga Islands, while the Telos Wireless Softswitch Management platform is used to execute all management procedures and is co-located with the softswitch in Los Angeles.

Putting it all together

The traditional telecommunication network (PSTN) is based on a hierarchical architecture, where any single long-distance call must pass through multiple switches to reach its destination. The cellular network's MSC is based on traditional Class 5 switches, and inevitably suffers from the same limitations, whilst incurring some problems of its own, arising from the special demands of mobile subscribers. In the case of mobile networks, all calls must first be delivered to a fixed point in the network (called the Gateway MSC), that is capable of determining the current location of the subscriber. The GMSC then delivers the call to the subscriber's location.

As the call passes through each switch, it consumes local resources: physical media and switch ports, the software and hardware resources that control the switching matrix, and the signalling hardware used to transfer the call control information.

Softswitch technology uses a layered approach to network architecture, implying that the traditional functions of a telephone exchange or MSC are split out into separate functional units. Protocols and access points defining the communication rules between these units are well defined. Use of a layer architecture results in the physical separation of the media control and signalling components of the MSC. This allows the media path to be totally independent of the control path. The signalling component only needs to inter operate with legacy TDM networks.

The wireless softswitch function consists of the mobility and radio aspects of a traditional MSC, along with the call control function and a media gateway control (MGC) function. The MGC function translates MSC-specific control requests, designed to manipulate a switching matrix, into media gateway (MGW) control protocol requests to control an MGW. The MGW control protocol may be either H.248/MEGACO or MGCP – see Table 1 'Softswitch terminology'. In the case of landlines, the user terminals can be IP capable, using the session initiation protocol (SIP) to establish media sessions with other SIP devices. SIP is also used to exchange information between softswitches.

Figure 2 illustrates call set up in a softswitch environment. The IP phone (terminal 1) initiates a session by dialling some digits and sending a message to the Class 5 softswitch (node 1). This message includes the phone's IP address, the UDP (user datagram protocol) port number on which the phone is listening for a connection, and the characteristics of the speech coding algorithm being used. This additional information, which goes under the umbrella title of session description protocol (SDP), is transparent to the softswitch controllers. The Class 5 softswitch identifies the dialled number

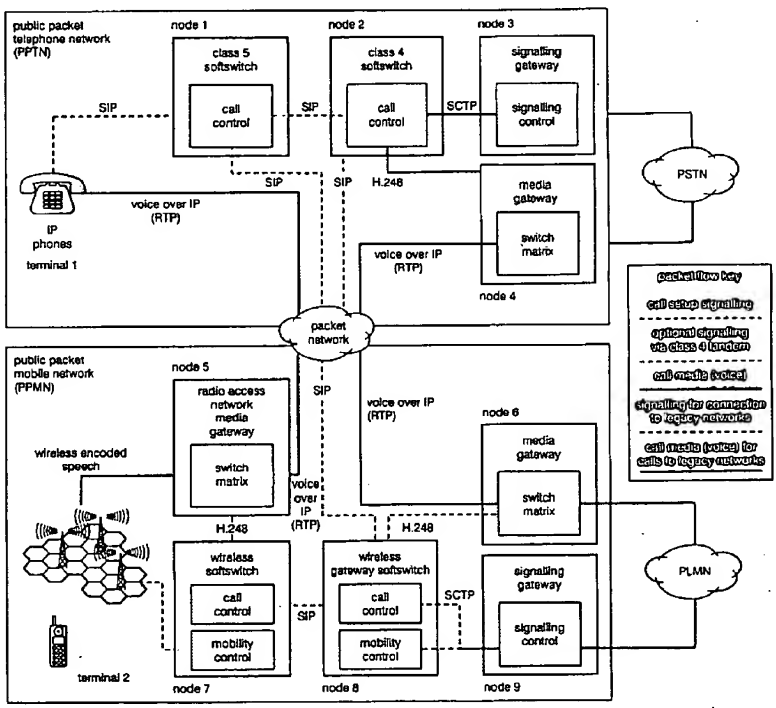
as a mobile terminal, and passes the call request and the caller's SDP to the nearest wireless gateway softswitch (node 8) using SIP.

If the Class 5 exchange is incapable of identifying mobile directory numbers, the call request will be passed to a Class 4 tandem exchange (node 2), which will identify the number and pass it to a wireless gateway softswitch. The path followed by the control messages does not affect how the media path will be set up.

The wireless gateway softswitch (node 8) uses GSM or IS41 MAP to locate the mobile customer, and then passes the SIP message, including the caller's SDP, to the wireless softswitch serving the mobile customer (node 7).

A radio access channel to the mobile customer (terminal 2) is created using the specific radio access protocol, GSM, CDMA or UMTS, and the bearer channel to the radio network is reserved by sending a media gateway control message, containing the caller's SDP, to the radio access network media gateway (node 5). The radio access gateway is responsible for negotiating and creating a media channel between the radio access network and the core packet network; this will either be a 64 kbit/s PCM channel or an ATM (AAL2) channel. When the channel has been successfully created, the gateway responds to the wireless softswitch with the IP address and the port number of the resource just created – collectively known as the called party's SDP.

The mobile (terminal 2) is now set to the alerting state. It starts to ring, and a message is sent back to the caller to indicate that the called party is being alerted. This will cause the caller's phone to provide a ring back tone. In a legacy network, the switch provides the ring back tone to the phone; however, in a packet network, there is no media stream until the called party



2 Using a softswitch network architecture to deliver a call to a mobile subscriber. Nodes 3, 4, 6 and 9 are used solely to connect packet and legacy networks

Table 1 Softswitch terminology

Acronym	Meaning	Description
AAL2	ATM Adaptation Layer 2	ATM transport with suitable characteristics for carrying voice media.
GSM-MAP Protocol	Mobility Application Protocol	The European mobility protocol standardised as TS 129 002.
IS41-MAP	Mobility Application Protocol	The North American EIA/TIA mobility protocol, standardised as ANSI-41.
H.248 MEGACO MGCP	Media Gateway Control Protocols	Any of these protocols may be used to allow the MGC to communicate MEGACO are the ITU and IETF with the MGW (Note: H.248 and designations of an identical protocol)
MGC	Media Gateway Controller	Controls establishment of connections in media gateways
MGW	Media Gateway	Performs media connections under direction of a controller
RTP	Real-time Transport Protocol	Provides a transport mechanism for time sensitive information streams (such as voice) across a packet network
SCTP	Stream Control Transmission Protocol	Provides reliable transmission characteristics for SS7-based protocols being signalled across an IP network
SDP	Session Description Protocol	Used to describe the characteristics of the end terminal (or end point)
SIP	Session Initiation Protocol	Simple protocol used by end devices to initiate a media session. Also used by controllers to communicate call information between themselves

answers, requiring all IP terminal devices to provide call progress tones (such as ring back). The alerting message also contains the called SDP provided by the radio access gateway (node 5). The IP phone (terminal 1) will use this SDP to establish a media stream to the radio access network gateway, when it is notified that the called mobile (terminal 2) has answered.

When the mobile customer (terminal 2) answers, a message is sent to the IP phone (terminal 1). It is now possible for the initiating device (the IP phone in this case) to establish an RTP stream with the terminating device–the media gateway (node 5). This stream is used to carry the voice packets.

Using the information on the speech algorithms contained in the SDP portions of the control messages, the media gateway converts the speech coding from a wireless form to a voice over IP form and transits packets from the IP side to the radio access network side, performing transport mapping as required, i.e. IP to ATM and ATM to IP, or IP to 64 kbit/s PCM and 64 kbit/s PCM to IP.

The wireless opportunity

While softswitches and packet networks will significantly lower capital and operating costs, the primary promise of this new network paradigm is the provision of new services. Because packet networks are converged, multimedia support is naturally and easily supported, allowing features and services to be introduced, used in trials, adopted and disseminated, with minimal impact on the network or its components. New features can now be easily and widely rolled out, and features provided for only a small market segment will become economically viable.

The next generation wireless networks will change the way we think about sending and receiving information. Ultimately, we won't be limited, and anytime, anywhere communication will soon become a reality. Wireless softswitch and packet architectures thus offer a compelling business proposition for both users (who will benefit from new advanced services), and network operators, who will recognise impressive business application opportunities for new revenue generation and cost reduction.

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